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GREAT RAINFALL AT HONG KONG, MAY 29 & 30, 1889.

IN the *Meteorological Magazine* for August last we printed a letter upon the above subject from Major Wilkinson, R.E., and gave also the remarkable, if not unprecedented, hourly record of the rainfall at the observatory.

We have recently received from Mr. Rogers Field, C.E., a copy of the report upon the storm by the Surveyor-General (Mr. Brown), and thinking it very desirable that it should be put upon record where it can be readily found, have reprinted those paragraphs which refer to the fall of rain, adding a few foot-notes by way of comment. We do not reprint the table of hourly fall, as it is given on p. 104 of our last volume; but we notice that it differs from our copy in the value for 1 p.m. on 29th, that was originally reported as 1·08, it now appears to be 0·08, and this reduces the total in the storm from 34·11 in. to 33·11 in.; but really in such a storm an inch more or less seems quite a trifle.

REPORT ON THE GREAT STORM AT HONG KONG, 29TH & 30TH MAY, 1889.

(*Presented to the Legislative Council by command of His Excellency the Governor.*)

To the HON. F. STEWART, LL.D., *Colonial Secretary.*

Surveyor-General's Office, Hong Kong,
July 27th, 1889.

SIR,—I have the honour to forward, for the information of His Excellency the Governor, the following report on the great rainstorm of 29th and 30th of May last, and damage caused thereby to public property.

2. The rainy season of the south-west monsoon appears to have set in earlier this year than usual. During the month of April over 12 inches of rain fell, and of this quantity nearly 7 inches was due to a storm on the 29th and 30th of that month, causing considerable damage to streets and roads which the Acting Surveyor General (Mr. Cooper) estimated at 3,400 rupees. The first half of May was comparatively dry. I arrived at Hongkong on the 18th of May.

The night after my arrival there was a very heavy thunderstorm, several buildings were struck by lightning, and 5·94 inches of rain were recorded during the day ending 10 A.M. on the 19th. On the three following days there was an aggregate fall of 5·88 inches, and there were showers at frequent intervals until the 28th. Early in the morning (2 A.M.) of 29th the rain began and continued almost uninterruptedly (although with greatly varying intensity) until 5 P.M. of the 30th.

3. On the morning of the 29th I was at the Peak, and such was the violence of the storm that (with some others who were staying at the Hotel) I had to wait a considerable time before the chair coolies would venture on the descent, owing to the force of the wind and rain. However we started about 9 A.M. I shall not readily forget the journey down. I followed the road as, all things considered, it appeared to me a preferable route to the tramway. Along the upper levels the gusts of wind threatened to carry us off the mountain path. During the descent the water rushed in sheets down the steep mountain slopes, the nullahs were full, and the side drains and culverts of the road overflowing. I arrived at the Government Offices about 10 o'clock. Shortly afterwards Mr. Bayne, Overseer (then in charge of streets, since deceased) came to report that the Glenealy culvert (which carries the storm water and sewage, and traverses the centre of the City, passing through Wyndham and Pedder's Streets, where several of the more important offices and public buildings are situated) had burst in several places. Before there was time to ascertain full details a watchman arrived to report that the service tank of the Tytam Water-works was in danger. Accompanied by Mr. Cooper I proceeded at once to the site. We arrived there a little before Noon, and found that the tunnel, or great culvert, 192 square feet in transverse area, which conveys the water of the Albany Nullah under the Tytam service tank was blocked, and the water that should pass through it was pouring over the concrete wall of the tank, and had washed away a large portion of the earthen bank on the down-stream side of the wall, as well as parts of the Bowen and Garden Roads, and had caused considerable damage to the banks of the Ravine. As the concrete walls of the tank were not designed, without the aid of the earthen bank, to resist the pressure of the water, there was good reason for taking immediate precautionary measures, so as to be prepared in the event of the failure of the tank. As the Murray Barracks are situated near the Harbour, in the bed of the same valley, 400 feet below the tank, which holds some 35,000 tons of water, I requested Mr. Cooper to give immediate notice to the officer in command of the Regiment there quartered, and I proceeded forthwith to inform His Excellency the General Commanding of the critical state of affairs. Orders were at once issued to clear the basement floors of men and stores.

4. I find on referring to the hourly record of rainfall kindly furnished, at my request, by the Director of the Observatory (Dr.

Doberck) that the rain began between 2 and 3 a.m. of the 29th and continned until about 1 p.m., up to which time 10½ inches of rain had fallen, of which 7¾ inches fell in the three hours before Noon (10 a.m. 3·06 inches, 11 a.m. 3·35 inches, 12 (Noon) 1·27 inches). There was then an interval of two hours without rain, after which it rained moderately until near midnight. Then began the most appalling thunderstorm within my own experience, or that, I venture to believe, of the majority of the residents in the Colony. For hours flash succeeded flash in rapid succession, and the roll of the thunder was almost uninterrupted, while the rain descended in masses. Several buildings were struck by lightning, and six coolies were killed in a matshed at the Peak. The damage to the structure, in the case of the buildings which I have had an opportunity of inspecting, was singularly slight. The storm raged with greatest intensity between the hours of 1 and 5 a.m. of the 30th. The rain that fell during that morning is so exceptional that I give below the result in detail.

5. After 6 a.m. the storm abated, but rain continued to fall until about 5 p.m., when it ceased. The total rain which fell during the storm from 3 a.m. of the 29th to 5 p.m. of the 30th, a period of 38 hours, was 33·11 inches, and of this quantity the very remarkable fall of 27·44 inches occurred in the 24 hours ending 6.30 a.m. of the 30th (nearly twenty-seven and a-half inches).

6. Before proceeding further it may be interesting to add that the total rainfall recorded for May was 48·84 inches, and for the six months ended 30th of June 75·45 inches. Comparing this with the records of the five years ending 1888, I find that the annual average is 84·84 inches, of which an average of 35·6 inches fell in the first half of the year, while the maximum monthly fall during these five years was 31·36 inches (in June, 1885). It therefore follows that the rainfall of the past half-year very nearly equals the average annual rainfall, and is more than double the quantity that fell in the corresponding period in former years, while the quantity that fell in May was one-third greater than that of any previous month, during these five years.

7. I have dwelt somewhat at length on this remarkable downpour because, as far as I am able to ascertain from the limited records accessible to me here, the aggregate rainfall during this storm is without precedent in the case of any storm of equal duration, and it is specially noteworthy that the fall during certain hours, and the maximum for 24 hours, appear (if I may be permitted the expression) to break the record. My authorities are two standard works on "Hydraulics," but the data are necessarily imperfect, as they do not extend to a later date than 1875. I would call attention, however, to this very interesting and important subject of enquiry, in the hope that my imperfect comparison may be supplemented (and corrected if necessary) by those who may have leisure for investigation, and access to more recent records. The practical importance of

the subject is manifest, since we must depend on the accuracy of the meteorological returns for guidance in designing works of drainage and water supply.

8. I should add that the observations were made at the Observatory at Kowloon, two miles north of the centre of the Victoria rainfall area. It is, I think, probable that the results may be safely assumed as indicating approximately the rainfall on the main island, but it would be well to bear in mind that the proximity of the steep mountain slopes to the City render it possible, judging by the records of analagous sites, that the rainfall in the City and on the mountain slopes above was greater, rather than less, than the rainfall at Kowloon.

9. For the purpose of comparison I will now quote some exceptional rainfalls recorded in other countries. At Nottingham, on 13th of August, 1857, $5\frac{3}{4}$ inches fell in about five hours. During my residence in Cyprus (December, 1880) a flood, disastrous to life and property, occurred at Limassol, where a fall of $5\frac{3}{4}$ inches was registered (nearly the whole falling in four hours). It is noteworthy that at Kowloon more than double this quantity fell in the same space of time. I can find no record *elsewhere* of a maximum hourly fall equal to that at Kowloon, viz., 3·4 inches, although it appears that the maximum on 30th May was slightly exceeded by an observation made at the Kowloon Observatory in July, 1886, when 3·48 inches was registered in one hour. Those who carefully observed the storm will, I think, agree with me, that when at its height the downpour was not constant for any considerable consecutive period, but that for short periods it was exceptionally severe, so that if the fall could have been measured for a limited period of say a quarter, or half an hour, I have little doubt that the result would have been at the rate of fully four inches per hour. In designing works in which it is necessary to provide for a maximum fall, it would in my opinion be unsafe, in the light of recent experience, to calculate on a smaller fall than four inches per hour.*

10. I would here remark that it may be argued that I am assuming that all the water that falls from the clouds is at once discharged into the water-courses, and that I am allowing nothing for absorption. To this I submit that in the case of a heavy rainfall, occurring on such steep slopes as those which form the background

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* During short periods far higher rates than four inches per hour must be provided for. Even in London it will be seen from *British Rainfall*, 1878, p. 79, that for

Half a minute	the rate may be		12·0	inches an hour.
One minute	,,	,,	10·2	,,
Five minutes	,,	,,	6·7	,,
Ten minutes	,,	,,	6·2	,,
A quarter of an hour	,,	,,	5·7	,,
Half an hour	,,	,,	4·6	,,

[ED. *M.M.*].

of the City, at a time when the soil has been saturated by previous heavy rains, a careful observer will, I think, be convinced that, practically speaking, all the water that falls is discharged forthwith into the sea.

11. To return to the records of rainfall in other places, the greatest fall in 24 hours I can find registered is 20·58 inches at Madras on 21st of October, 1846. The maximum at Kowloon was 27·44 inches, or about one-third greater.

12. I may conclude my observations on rainfall by adding, that although the records of Hongkong appear to be exceptional, as regards the rain which fell in a single hour, and during periods of four hours, and of 24 hours, the recorded *monthly* and *annual* rainfall of this Colony sink into insignificance compared with those of some other parts of the world. If we take the returns for Hongkong of the past six years we find that the maximum monthly rainfall is 48½ inches, and the maximum annual fall is 109 inches, while at Cherrapungi in Assam at 4,460 feet above sea level, 243 inches have been gauged in a single month (June, 1860) and during the same year 615 inches of rain fell. The monthly and annual rainfall at Cherrapungi is therefore more than five times greater than Hongkong.

13. I have been unconsciously led into considerable length on the question of rainfall, owing to the interesting nature of the enquiry, and the phenomenal character of the late storm. The subject is not without a practical application, for as the storm was exceptional in its nature, so also was the injury that resulted to public and private property; and it is noteworthy that the periods when the greatest damage occurred coincided precisely with the hours of maximum rainfall, *i.e.* from 10 a.m. to Noon of the 29th and from 3 to 6 a.m. of the 30th. No doubt exaggerated estimates were made at the time of the loss incurred, but this was not surprising; as the ruin wrought by the uncontrollable power of this rush of water was evident on every side, and was on a scale, and of a nature, to impress the imagination.

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I have the honour to be, Sir,
Your obedient Servant,
S. BROWN, *Surveyor-General.*

P.S.—Since writing the above, I find that Chambers' "Encyclopædia" (ed. 1882), and the "Encyclopædia Britannica" (ed. 1884), state that at Joyeuse (France) 31·17 inches fell in 22 hours; at Geneva (Chambers says Genoa) 30 inches in 24 hours; at Gibraltar, 33 inches in 26 hours; on the hills above Bombay, 24 inches in one night; and on the Khasia Hills* (Assam) 30 inches on each of five successive days. These falls, if correctly reported, exceed that

* Another name for Cherrapungi.

registered here, but as no details are given, nor authorities quoted I hesitate to accept these statements without further evidence.*—S. B.

GREAT RAINFALL IN CEYLON, SEPTEMBER, 1872.

[As bearing on the above-mentioned excessive rainfall in Hong Kong, we have been favoured by Sir J. Coode, Pres. I.C.E., with the following brief but very useful memorandum.—ED.]

Extract from Proceedings of the Commission appointed by the Government of Ceylon to Report upon the floods that occurred there in the latter part of September, 1872.

"The rainfall during the first twelve days of last September was very great throughout the Central and Western Provinces. At Mocha estate, in Maskeliya, 34·02 inches of rain fell in 96 hours; at Yellangoury, in Dolosbágé, 23·94 inches fell in the same time."

"From the return of rainfall published by the Director of Public Works, it appears that 17·90 inches of rain fell at Avisáwélla from the 8th to 9th September; 18·80 inches at Padapolla."

ANEMOMETERS AND DAMAGE BY GALES OF WIND.

To the Editor of the Meteorological Magazine.

SIR,—Several *gales*, commonly so-called, have swept over this district lately, and occasioned damages to structures, and trees, &c., of more or less serious extent.

The Forth Bridge has escaped damage entirely, but some materials were blown off from a truck in a passing goods train. The Exhibition had a scaffolding erecting for a panorama blown down, and the Royal Infirmary had a portion of the outside railings exposed to the S.W. gale levelled.

What is of peculiar interest is the interpretation to be placed on the readings of the anemometers observed here, and elsewhere, in face of these results by storm to structures erected on the ground.

The plate anemometers at the Inchgarvie Station, at the Bridge on the Forth (*Scotsman*, March 12th, 1890), indicated pressures at the rate of 30 lbs. per sq. ft. (78 miles per hour), for the small gauge, and 16 lbs. per sq. ft. (56 miles per hour), for the large gauge.

The anemometers at the Paris Exhibition last season (*Times*, March 13th, 1890), indicated that at the top of the Eiffel Tower, the mean velocities were 15·5 miles per hour, and at the Observatory in the City they were only 5 miles for the corresponding period.

One would expect from these observations that portions of the highest edifices or structures would have been blown down in preference to those at the lowest levels, but here in actual practice is seen the anomaly of structures being damaged at the *lowest stages*, where the pressure of the gale per sq. ft. would be least.

Again, one would imagine that large structures would suffer from

* We are rather of Mr. Brown's opinion, but have already dealt with the subject in *Met. Mag.*, vol. xxiii. (1888), p. 99.

wind more than smaller ones would do, but there is less pressure by one half by wind recorded on the large anemometers than on the smaller ones.

An explanation of this may probably be found in the greater proportion of length of edge or border to superficial area of square feet in the object assaulted, whereby the wind gets more surface of *turning friction*, and less surface for the calm centre.

A plate anemometer with respect to the action of the wind on it, is much in the same relation as the surface of the earth is to an anti-cyclone, that is, the most wind is found on the borders of the anti-cyclone, while the middle of it is taken up by a calm centre.

Thus an anemometer plate of 30 ft. square has 120 ft. of border for the wind to turn over on, and a space of 900 sq. ft. for a *calm centre* inside this border of out-flowing wind.

But a plate anemometer of 3 feet square would have, on the contrary, only a space of 9 square ft. of area for a calm centre, and a length of 12 feet for a border for the wind to turn over.

So that the length of border in the large and small square wind gauges would be as 10 to 1, but the areas for the calm centres would be as a 100 to 1 ; therefore the small plate anemometer must always indicate 2-3 times more pressure than the larger one, from having proportionately more border to area.

From this it will follow that a more suitable form of plate anemometer wonld be the circular one, while the lengths of the borders would be more approximate to the areas inside them, in both large and small gauges, and the form would also favour the anti-cyclone-like motion of the gale of wind.

Thus, a circle of 30 feet diameter would have a border of 94 feet, and an area of 706 square feet, and a circle of 3 feet diameter would have a border of 9·4 feet and an area of 7 square feet. Each of these sets would have ratios of border to border and area to area of 10 to 1, so that both large and small anemometers of a circular shape would represent the pressure of the same gale equally anywhere at the same time.

It follows from this that there would be expected to be less wind or gale pressure on solid or filled up wall surface of any structure than on any open structure, such as scaffolding, trellis-work, ballustrading, &c.

In the former case the wind would blow over it, leaving a calm centre inside of less pressure than at the edges, and in the latter the wind would pass through it with much friction on the sides of the bars, poles, pillars, &c., composing an open edifice, and there would be no calm centre at all to compensate for this.

Open structures, like scaffolding, therefore require to be supported by *struts* to withstand any wind pressures, conjoined, as these are, with increased friction.—Yours,

W. J. BLACK, F.R.C.S.E., F.R.Met.Soc.

Cal. United Service Club, Queen Street, Edinburgh.

"AREAS OF RAREFACTION" OR "DEPRESSIONS."

To the Editor of the Meteorological Magazine.

SIR,—In his letter on this subject in the Magazine for April, Dr. Muirhead has given us a very good description of the "filling up" of a low pressure system or cyclone, except that he seems to overlook the fact that the axis of revolution of a cyclone is inclined forwards in the direction of its motion, the lower part being retarded by friction against the surface of the earth, so that, while the general tendency of the revolving wind may be upwards, there will be a down-rush in the rear of the cyclone, a fact which accounts for the sudden fall of temperature commonly observed when the wind shifts to N.W., as the centre passes to the eastward of the observer in the northern hemisphere, the fall being generally far too great to be accounted for by the small difference in latitude between the points from which the northerly and southerly winds respectively originate in an ordinary cyclone.

But the point at issue between us is *not* how a low pressure system is "*filled up*," but how it *originates*—what it is in its initial stage. Dr. Muirhead maintains that low pressure systems are simply "areas of rarefaction," caused by local heat; my contention, on the other hand, is that this theory altogether fails to explain some of the characteristic features of the more important low pressure systems, such as those which at certain seasons of the year pass in rapid succession over our islands or their neighbourhood from the Atlantic (and it is chiefly these that the "meteorological authorities" whose nomenclature Dr. Muirhead finds fault with, refer to in their forecasts); and that a better explanation of them is to regard them as actual eddy-like depressions, originally formed in the great atmospheric currents which sweep over large areas of the globe.

Dr. Muirhead appears to consider this theory so ridiculous as to be quite unworthy of a F.R.Met.Soc., though it might be excusable in one of the "general public" who was ignorant of the simplest principles of meteorology. What does he think, then, of the following passage, penned by one who is not only a F.R.Met.Soc., but actually a secretary of that august body, and also secretary of the Meteorological Office—Mr. R. H. Scott?—"If we suppose the atmosphere to be a liquid, like the sea, and enveloping the earth, we may imagine that portion of it which lies over the Atlantic Ocean in our latitudes to be like a gigantic river. . . . . On the surface of such a river we often see small waves and eddies, each with its own circulation, which are carried along with the stream. If we could look at the upper surface of the atmosphere, *supposing it to be homogeneous and of equal density throughout*, we should see somewhat similar conditions; what corresponds to the crest of the waves being patches of excessive pressure, while what corresponds to the eddies would be the areas of defective pressure. The surface, if suddenly congealed, would present the appearance of a number of

isolated mounds and pits, with very little level area at all. . . . . The pits would have steep sides, be deep, and of comparatively small diameter; while the mounds, on the contrary, would be flat-topped and extensive in area. The pits are what are called barometrical depressions or cyclonic systems, from the Greek word κῦκλος, because the wind whirls round them; the mounds are the areas of high pressure, called anti-cyclones, because they are the opposite of cyclones." ("Elementary Meteorology," by R. H. Scott, pp. 352-3, 1st Edition). I do not overlook the importance of the qualifying words in italics, but I think I may claim, that the view which Mr. Scott here formulates in reference to the origin of low pressure systems agrees in the main with that which I advocate.

But I can claim higher authority even than that of Mr. Scott, for this view, viz., that of the late Sir John Herschel. I do not know whether he was a fellow of the Meteorological Society: if not all I have to say is (to paraphrase a well-known saying of George Stephenson), "So much the worse for the Meteorological Society." "We have," he writes, "to consider the globe as entirely and deeply covered by an atmosphere of mixed gases—highly elastic, very dilatable by heat, and of extreme mobility: expanding itself in virtue of its elasticity out into space far above the tops of the highest mountains; yet, in virtue of its compressibility, so condensed (comparatively) in its lower strata as that one-third of its total ponderable mass lies within a mile of altitude above the sea-level, nearly one-half within two, and nearly two-thirds within five miles, within which latter limit the whole would be contained were it everywhere of the same density as on the surface; so that only about one third of its total mass is free to range unimpeded by the crests of the highests Himalaya; and not much more than two-fifths can entirely clear the range of the Andes without pressure á tergo. In consequence, when driven in the state of *wind* over these or other mountain ranges it is thrown up into vast ripples or waves, which are propagated thenceforward onwards over indefinite areas of land or sea, and become no doubt the origin of a great part of those casual fluctuations of the barometer, which give so much trouble to meteorologists." ("Popular Lectures on Scientific Subjects," by Sir John Herschel, New Edition, pp. 150, 151). That seems to me a reasonable theory of the origin of low pressure systems, and one which explains the phenomena far better, at any rate as regards the larger disturbances, than Dr. Muirhead's somewhat crude theory of areas of local rarefaction. I had intended to state for Dr. Muirhead's consideration, some well-known facts observed in connection with low pressure systems, which seem to me to stand in the way of the acceptance of his theory; but I feel that I have already occupied more than my share of space in this month's magazine. If you are willing that the discussion should be continued in your columns, you will perhaps allow me to return to the subject on a future occasion. I will only, in conclusion, express the hope that the subject may be

fully and worthily discussed, and reciprocate Dr. Muirhead's wish, "that he or I, or both of us, may be set right."

G. T. RYVES.

Tean Vicarage, May 5th, 1890.

CYCLES OF DROUGHT AND GOOD SEASONS IN AFRICA.

To the Editor of the Meteorological Magazine.

SIR,—With reference to your review, last month, of my "Cycles of Drought and Good Seasons in S. Africa," I trust you will allow me a few lines to explain.

The error of one year, noted at page 125, affects the one reference only, and this not really, for an inspection of the Cyclical Diagram at page 78 will show that the rains of the 9·5 years' cycle have invariably run into a second year.

In the more recent second lecture, containing forecasts of the character of the seasons in S. Africa for the next 50 years, sun-spots, as observed, are, for forecasting purposes, discarded, and the following *three cycles only* employed: (1) 11·11 years; (2) 9·5 years; (3) 12·5 years.

In fixing dates with fractions the usual rule of taking the nearest whole figure is adopted. It is also explained in the text that with seasonal rains, as in S. Africa, the fractional half-year of a cycle becomes a whole year every two years. Thus a glance at the Cyclical Diagram for Cape Town shows that the rains of the 9·5 years' cycle—the heaviest rains at Cape Town—fall *with absolute punctuality* every nine and ten years alternately. These and all the other rains at Cape Town show a cyclical regularity, which to me, when I first studied the subject, seemed amazing. Had any one suggested such a regularity to me a few years ago, I should have viewed it with the amused incredulity that runs through your review. It is not necessary to wait ten years, as you suggest, to verify my forecasts. The odds in their favour are 49 to 1 in the case of the Cape Town meteorological records. One cannot suppose that cycles, which have rolled through their periods with unswerving regularity for 49 years, will now change, because we have mapped, and arrived at an understanding of, them! Fortunately in one sense, unfortunately in another, cyclical meteorology, as it exists in the Cape climate, is such an entirely new departure that it is difficult to get English meteorologists to examine the subject seriously.

There is every variety of climate in South Africa, from nearly rainless desert tracts to forest-clad mountains, with an average of 50 or 60 inches per year. It is certain that no writer who has not lived in the country has understood its meteorology. Most English and German writers—notably Dove recently—have fallen into the error of grouping heterogeneous stations.

It is unfortunate that "lag" rains have been misunderstood in your review. The lagging, where it occurs, is a *constant* local factor

not a promiscuous, one, two, or three years, thrown in where wanted to support a theory, as your review suggests. The nature and incidence of the lag rains of Eastern S. Africa are fully explained in the text, they being the most prominent feature in the meteorology of that portion of the continent.

I am, Sir, yours faithfully,

D. E. HUTCHINS.

Budleigh Salterton, Devonshire, 27th April, 1890.

[When an author has not merely discovered the laws of the seasons for fifty years to come, but has the odds in his favour of 49 to 1, it is natural that he should object to anything except adulation. Mr. Hutchins has not told us when his 11·11, 9·5, and 12·5 years are to start from, and, because two of his cycles have half years, seems to think that that is the only fraction with which he has to deal. Very little arithmetic is requisite to show that the matter is by no means so simple. As regards his discovery, which, if real, is probably the greatest ever made in meteorology, we adhere to our previous words, "When Mr. Hutchins can bring up evidence of 10 years' success, we will do all in our power to ensure him the honour he will merit."—ED.]

ROYAL METEOROLOGICAL SOCIETY.

THE monthly meeting of this Society was held on Wednesday evening, April 16th, at the Institution of Civil Engineers, 25, Great George Street, Westminster, Mr. Baldwin Latham, C.E., F.G.S., President, in the chair.

The Marquis of Gallidoro and Mr. J. M. Veevers were elected Fellows of the Society.

The following papers were read :—

1. "The Cold Period at the beginning of March, 1890," by Mr. C. Harding, F.R.Met.Soc. At the commencement of the month a rather heavy fall of snow was experienced in many parts of England, and very cold weather set in over the Midland, Eastern, and Southern districts, the temperature on the 3rd and 4th falling to a lower point than at any time in the previous winter. The lowest authentic thermometer readings, in Stevenson screens, were 5° at Beddington, 6° at Kenley in Surrey and Hillington in Norfolk, 7° at Chelmsford and Beckenham, 8° at Addiscombe, 9° at Reigate and Brockham, and 10° in many parts of Kent and Surrey. At Greenwich Observatory the thermometer registered 13°, which has only once been equalled in March during the last 100 years, the same reading having occurred on March 14th, 1845. During the last half-century the temperature in March has previously fallen below 20° in only three years, whilst during the whole winter so low a temperature has occurred in only eight years out of the fifty.

2. "Note on the Whirlwind which occurred at Fulford, near York, March 8th, 1890," by Mr. J. E. Clark, B.A., B.Sc. A sharp and heavy thunderstorm occurred at York about 2.30 p.m. At the

same time, or shortly afterwards, a whirlwind passed a little to the south of the city, from Bishopsthorpe to Heslington, a distance of about four miles, its width varying from three or four to 250 yards. The author made a careful survey of the track of the whirlwind, and described the damage done by it to trees, buildings, &c.

3. "On the possibility of Forecasting the Weather by means of Monthly Averages," by Mr. A. E. Watson, B.A., F.R.Met.Soc. The author's method seems to be (1) to ascertain the average temperature, rainfall, &c. of each month; (2) to consider whether the previous months had had temperatures, &c. above or below the mean, and to assume that any such departure would be compensated in the month about to commence.

REVIEW.

Différentes formes des grêlons observés au sud-ouest de la Russie. Par Prof. A. KLOSSOVSKY. 8 vo. 14 pages, 2 plates.

OUR readers will remember that we have already drawn attention to Professor Klossovsky's work on "Thunderstorms in Russia."* In the course of 1886, he organized a series of stations for the observation of thunderstorms in the south-west of Russia; there are now no fewer than 230 such stations, and in the four years 1886-89, they sent in more than 6,000 reports—that is to say, on the average each station reported six or seven storms each year. From these reports the best of those upon remarkable falls of hail have been reproduced in this pamphlet, which is accompanied by two plates giving views and sections of the most noteworthy stones, all drawn to the natural scale. The storms dealt with are in number only eight, but of some there are two or three reports.

The largest hailstone was roughly circular 2 in. in its greatest, and about 1·8 in. in its least diameter; it was somewhat foliated in outline, but on the whole perhaps more like a round nodule of iron pyrites than anything else. It fell at the village of Zélënovka, in Kherson [about 48° 30′ N. and 32° 30′ E.], in the afternoon of August 19th, 1887. It had a crystalline bluish centre, and layers of more or less opaque ice around it. This was in point of size and weight far inferior to those seen and modelled by Mr. Stratten as falling at Montereau, France, August 15th, 1888, and which have been well engraved, natural size, in the *Quart. Jour. Roy. Met. Soc.* Vol. xv. p. 48.

Another stone which fell at Ratchky, in Podolia [about 49° N., and 29° E.], somewhat resembles the lady's-hand-glass pattern, frequently seen in Bavaria by Col. Ward, and engraved in the *Meteor. Mag.* Vol. xv., 1880, p. 33.

With a staff of 230 observers scattered over the vast level plains of Southern Russia, Professor Klossovsky has special facilities for the study of the formation and motion of thunderstorms, and we anticipate with pleasure further reports from him.

* *Met. Mag.*, Vol. xxi. (1886) p. 1.

SUPPLEMENTARY TABLE OF RAINFALL, APRIL, 1890.

[For the Counties, Latitudes, and Longitudes of most of these Stations, see *Met. Mag.*, Vol. XIV., pp. 10 & 11.]

Div.	STATION.	Total Rain.	Div.	STATION.	Total Rain.
		in			in.
II.	Dorking, Abinger Hall.	3·21	XI.	Castle Malgwyn	1·09
,,	Margate, Birchington...	2·25	,,	Builth(Llanwrtyd Wells)	1·47
,,	Littlehampton	2·57	,,	Rhayader, Nantgwillt..	2·05
,,	Hailsham	2·81	,,	Carno, Tybrith	1·94
,,	Ryde, Thornbrough	3·01	,,	Corwen, Rhug	1·14
,,	Alton, Ashdell.....	2·39	,,	I. of Man, Douglas	1·89
III.	Oxford, Magdalen Col...	1·03	XII.	Stoneykirk, Ardwell Ho.	1·03
,,	Banbury, Bloxham	1·14	,,	New Galloway, Glenlee	1·97
,,	Northampton	1·00	,,	Melrose, Abbey Gate...	·98
,,	Cambridge, Fulbourne..	·95	XIII.	N. Esk Res. [Penicuick]	1·50
,,	Wisbech, Bank House..	·51	XIV.	Ballantrae, Glendrishaig	1·14
IV.	Southend	1·91	,,	Glasgow, Queen's Park.	1·33
,,	Harlow, Sheering	·94	XV.	Islay, Gruinart School..	1·75
,,	Rendlesham Hall	·86	XVI.	Dollar.....	·95
,,	Diss	·91	,,	Balquhidder, Stronvar..	2·58
,,	Swaffham	·60	,,	Dunkeld, Inver Braan..	1·62
V.	Salisbury, Alderbury...	2·65	,,	Dalnaspidal H.R.S. ...	4·28
,,	Warminster	2·79	,,	Arbroath Cemetery.....	..
,,	Bishop's Cannings	1·76	XVII.	Keith H.R.S.	1·54
,,	Ashburton, Holne Vic....	4·19	,,	Forres H.R.S.	·72
,,	Hatherleigh, Winsford.	2·71	XVIII.	Fearn, Lower Pitkerrie.	1·11
,,	Lynmouth, Glenthorne.	2·90	,,	Loch Shiel, Glenaladale	4·81
,,	Probus, Lamellyn	2·99	,,	N. Uist. Loch Maddy ...	2·67
,,	Launceston, S. Petherwin	3·14	,,	Invergarry	3·75
,,	Wincanton, Stowell Rec.	3·06	,,	Aviemore H.R.S.	...
,,	Taunton, Lydeard Ho...	3·23	,,	Loch Ness, Drumnadrochit	1·66
,,	Wells, Westbury	2·62	XIX.	Lairg H.R.S.	...
VI.	Bristol, Clifton	1·14	,,	Scourie	2·31
,,	Ross	1·01	,,	Watten H.R.S.	1·39
,,	Wem, Clive Vicarage ...	1·14	XX.	Dunmanway, Coolkelure	3·83
,,	Cheadle, The Heath Ho.	1·36	,,	Fermoy, Gas Works ...	1·43
,,	Worcester, Diglis Lock	1·09	,,	Tipperary, Henry Street	1·55
,,	Coventry, Coundon	1·49	,,	Limerick, Kilcornan ...	1·09
VII.	Ketton Hall [Stamford]	.82	,,	Miltown Malbay.....	1·40
,,	Grantham, Stainby	·60	XXI.	Gorey, Courtown House	1·57
,,	Horncastle, Bucknall ...	·18	,,	Navan, Balrath	·99
,,	Mansfield	...	,,	Mullingar, Belvedere ...	1·27
VIII.	Neston, Hinderton	1·09	,,	Athlone, Twyford	1·46
,,	Knutsford, Heathside ...	1·02	,,	Longford, Currygrane...	1·34
,,	Lancaster, South Road.	1·63	XXII.	Galway, Queen's Coll...	1·67
,,	Broughton-in-Furness ..	2·54	,,	Clifden, Kylemore	2·58
IX.	Wakefield Prison	·65	,,	Crossmolina, Enniscoe..	2·31
,,	Ripon, Mickley	1·01	,,	Collooney, Markree Obs.	1·86
,,	Scarborough, West Bank	·92	,,	Ballinamore, Lawderdale	..
,,	East Layton[Darlington]	·81	XXIII.	Warrenpoint	1·67
,,	Middleton, Mickleton..	1·31	,,	Seaforde	1·24
X.	Haltwhistle, Unthank..	1·35	,,	Belfast, New Barnsley..	1·84
,,	Shap, Copy Hill	1·65	,,	Bushmills, Dundarave...	1·18
XI.	Llanfrechfa Grange	1·27	,,	Stewartstown	1·78
,,	Llandovery	2·07	,,	Buncrana	1·82

APRIL, 1890.

Div.	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average. 1880–9	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE Max. Deg.	Date	Min. Deg.	Date	No. of Nights below 32° In shade.	On grass.
		inches	inches.	in.								
I.	London (Camden Square) ...	2·02	+ ·28	·54	25	16	64·3	30	30·5	5	3	12
II.	Maidstone (Hunton Court)...	2·78	+ 1·08	1·23	25	11	...	...	...	...	...	...
,,	Strathfield Turgiss	1·70	+ ·10	·33	23	17	66·3	30	25·3	5	6	17
III.	Hitchin	·62	— 1·17	·23	15	15	62·0	30	28·0	1	6	...
,,	Winslow (Addington)	1·21	— ·71	·22	26	15	64·0	30	23·0	2, 5	7	15
IV.	Bury St. Edmunds (Westley)	·84	— ·82	·20	21	11	...	...	...	...	...	...
,,	Norwich (Cossey)	·91	— ·80	·20	8	15	...	...	...	...	...	...
V.	Weymouth(LangtonHerring)	3·00	+ 1·12	·73	24	18	60·0	15	31·0	4, 12	3	...
,,	Barnstaple	2·54	+ ·36	·81	23	13	61·0	16	31·0	4	...	..
,,	Bodmin (Fore Street)	3·18	+ ·11	·94	24	18	..	...	...	...	..	...
VI.	Stroud (Upfield)	·97	— 1·18	·15	23	16	64·0	30	31·0	1*b*	6	...
,,	ChurchStretton(Woolstaston)	1·02	— 1·32	·23	25	12	63·0	30	29·0	4	7	14
,,	Tenbury (Orleton)	1·52	— ·56	·42	15	14	65·0	30	24·2	2, 4	10	13
VII.	Leicester (Barkby)	·82	— 1·28	·16	15	14	71·0	30	20·0	1	11	20
,,	Boston	·50	— 1·21	·16	6	10	70·0	29	24·0	2*c*	7	...
,,	Hesley Hall [Tickhill].....	·33	— 1·38	·11	7	10	68·0	30	24·0	1	10	...
VIII.	Manchester(PlymouthGrove)	·74	— ·97	·27	6	12	68·0	30	29·0	11	4	9
IX.	Wetherby (Ribston Hall) ..	·65	— 1·20	·23	13	9	...	...	...	...	...	..
,,	Skipton (Arncliffe)	2·38	— 1·05	·78	6	14	63·0	30	28·0	10	6	...
,,	Hull (People's Park)	·82	— 1·10	·25	12	14	...	...	...	...	...	...
X.	North Shields	·50	— 1·17	·15	7	10	63·0	30	28·0	11	9	14
,,	Borrowdale (Seathwaite).....	4·55	— 2·59	1·50	6	13	...	...	...	...	...	...
XI.	Cardiff (Ely).....	2·12	— ·29	·38	23	17	...	...	...	...	...	...
,,	Haverfordwest	1·79	— ·84	·40	6	12	59·0	14*a*	25·0	11	7	9
,,	Plinlimmon (Cwmsymlog) ...	2·19	...	·84	6	9	...	...	...	...	...	...
,,	Llandudno.....	1·09	— ·72	·23	10	11	64·8	30	32·0	12	1	...
XII.	Cargen [Dumfries]	1·44	— ·79	·47	21	12	62·8	30	25·6	12	10	...
,,	Jedburgh (Sunnyside).....	·77	— ·93	·18	24	13	64·0	30	24·0	13	12	...
XIV.	Old Cumnock	1·91	— ·22	·40	22	13	64·0	30	20·0	10	15	...
XV.	Lochgilphead (Kilmory).....	3·15	+ ·34	·55	20	13	...	...	...	...	...	...
,,	Oban (Craigvarren)	2·09	...	·50	6	12	58·6	30	31·1	13	2	...
,,	Mull (Quinish).....	2·25	— ·73	·36	21	13	...	...	...	...	...	...
XVI.	Loch Leven Sluices	·70	— 1·52	·30	22	...	...	...	...	...	...	...
,,	Dundee (Eastern Necropolis)	·65	— 1·40	·15	21	8	64·0	2	28·4	13	5	...
XVII.	Braemar	1·81	— ·61	·36	21	17	59·3	3	21·8	14	11	23
,,	Aberdeen (Cranford)	1·46	...	·27	28	23	62·0	3	26·0	12	5	...
XVIII	Strome Ferry.....	2·47	— ·45	·86	6	13	...	...	...	...	...	...
,,	Culloden	·49	— ·55	·20	23	...	61·0	2	25·0	13	6	22
XIX.	Dunrobin	...	...	...	...	...	...	...	...	...	...	...
,,	S. Ronaldsay (Roeberry).....	...	...	...	...	...	...	...	...	...	...	...
XX.	Cork (Blackrock)	1·33	— 1·56	·21	23	14	69·0	27	30·0	2	1	...
,,	Dromore Castle	2·31	— 1·30	·52	6	12	66·0	5	31·0	2	...	...
,,	Waterford (Brook Lodge) ...	1·30	— 1·17	·28	23	15	61·0	21	28·5	4	3	...
,,	O'Briensbridge (Ross)	1·10	...	·43	6	13	61·0	30	31·0	3	4	...
XXI.	Carlow (Browne's Hill)	...	...	...	...	...	...	...	...	...	...	...
,,	Dublin (FitzWilliam Square)	1·58	— ·54	·44	15	14	63·6	20	31·2	3	1	12
XXII.	Ballinasloe	1·16	— 1·18	·19	6	16	59·0	20	26·0	3	9	...
XXIII	Waringstown	1·43	— ·99	·19	24	18	65·0	28	25·0	2	7	12
,,	Londonderry (Creggan Res.).	1·67	— ·57	·27	9	15	..	...	...	...	...	...
,,	Omagh (Edenfel)	1·72	— ·51	·33	25	16	64·0	28	30·0	2	4	8

ENGLAND. WALES. SCOTLAND. IRELAND.

a And 15, 28, 29. *b* And 3, 4, 10, 11. *c* And 5, 12.

+ Shows that the fall was above the average; —that it was below it.

METEOROLOGICAL NOTES ON APRIL, 1890.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; T S for Thunderstorm; R for Rain; H for Hail; S for Snow.

ENGLAND.

STRATHFIELD TURGISS.—The weather of this month in particular, and of the spring in general, has been so pre-eminently favourable for farming operations, that the British farmer will have to look about for something else to grumble at, the only grievance in this district being that the bloom of the fruit trees has suffered from night frosts.

ADDINGTON.—Very sharp frost on 2nd and 5th, and the nights cold throughout the month. Bar. very low on 15th, 16th and 17th; on 17th a dense fog lasted all day. Swallow arrived on 15th, cuckoo heard on 16th, and nightingale on 27th. R from January 1st to April 30th 5·70 in., the least registered in the first four months of the year during 20 years.

BURY ST. EDMUNDS, WESTLEY.—A dry month, with many slight frosts. The hay crop is likely to be short in Suffolk.

LANGTON HERRING.—R ·79 in. above the average of 15 years. Mean temp. at 9 a.m. 1°·5 below the average. Solar halos were frequent. Dense fogs on 6th, 21st, and 22nd.

BODMIN, FORE STREET.—A very cold month; very high winds on several days from the N. and N.W. L on the 15th; S, sleet and H on the 10th. A splendid warm summer's day on the 30th.

STROUD, UPFIELD.—About an inch of S fell on the 10th about 6 a.m., and melted by 10 a.m. T heard in the E. and W. on the 16th.

WOOLSTASTON.—A rather cold month, especially the first fortnight, during which there were constant frosts. S fell on 10th. Mean temp. 44°·4.

LEICESTER, BARKBY.—Hailstorm and L on the 7th. First swallow seen on the 16th, cuckoo on the 24th.

BAWTRY, HESLEY HALL.—A cold, dry month.

MANCHESTER, PLYMOUTH GROVE.—The R was the smallest in April for 23 years, excepting 1873. Mean temp. 46°·8. Thick fog on the morning of the 5th; bitterly cold E. winds from 14th to 19th; the last ten days fine, and mostly bright and sunny.

HULL.—The weather during the month was generally dry, often with cold E. or N.E. winds; overcast or very cloudy from the 12th to the 24th, much less so during the early and latter parts of the month.

WALES.

HAVERFORDWEST.—A very dry, fine April. The wind blew with considerable force from N. and E. on 15 days, from the W. and S.W. on only 7 days, the remainder from N.W., consequently the temperature was below the mean, and the sky mostly cloudless, with sharp night frosts; a wholesome check was thus put to vegetation, which was unusually forward, owing to the mildness of March. Blackthorn in blossom on the 4th, horse chesnut in leaf on the 15th; cuckoo heard on the 24th.

SCOTLAND.

CARGEN.—The mean temp. of the month (44°·4) was 1°·5 below the average. Easterly winds prevailed for 18 days. Sunshine (165 hours) exactly the average. The low temp. of the month somewhat checked vegetation, which, however, was considerably in advance of what it usually is at this season. The

R of the first quarter of the year (11·32 in.) is 2·87 in. below the average of 30 years. T, L, and heavy H on 26th; T and S showers on 7th.

JEDBURGH.—N., N.E., and S.E. winds prevailed, often with frost, but there was a good deal of sunshine. Vegetation progressed little. Temp. low.

OBAN, CRAIGVARREN.—A fine seasonable month, with moderate R, and warm weather.

CULLODEN.—Little R fell during the month, and the temp. was very low, frost occurring nearly every night; vegetation much retarded.

IRELAND.

CORK—On the whole a genial month, only one shade frost. R less than half the average of 25 years. Mean temp. 50°·6, 2°·7 below the average of 14 years.

WATERFORD, BROOK LODGE.—A good deal of E. wind during the month; mean temp. 47°·3.

ROSS, O'BRIENSBRIDGE.—R small; harsh cold winds from N.E., S.E,, and N.W. prevailed, checking vegetation. A rise of temp. occurred on 27th, and the last three days were genial and pleasant. Frosts very slight.

DUBLIN.—April was generally a favourable month. The mean temp., R and rainy days were all somewhat below the average. Considered by weeks, the weather was first fine, dry and quiet; then cold and showery; then dull and cheerless; then unsettled, squally and showery, and lastly fine. Mean temp. 47°·3. Lunar halo on 24th; foggy on eight days; high winds on 11 days, on two occasions attaining the force of a gale. S or sleet on 10th, H on five days. Temp. in screen exceeded 50° on 23 days. T in W. at 0.10 p.m. on 26th.

OMAGH, EDENFEL.—The month commenced with brilliant weather, and as a seed time was excellent throughout, but the prevalence of dry easterly winds, and frequent night frosts, occasioned vegetation to be but little further advanced at the close than at the commencement.

WEATHER FORECASTING.

To the Editor of the Meteorological Magazine.

SIR,—In a report of the April meeting of the Royal Meteorological Society, published in "Nature" [April 24th, 1890, page 598], the following sentence appears:—"On the possibility of forecasting the weather by means of monthly averages, by Mr. A. E. Watson. The author is of opinion that the average values of meteorological phenomena are constant quantities, and that any variation from them is sure to be met by a compensating variation in the opposite direction."

This no doubt states a very interesting and important fact which I may be bold enough to add is quite independent of the opinion of Mr. A. E. Watson—but surely my brother Fellows of the Roy.Met. Soc., knew it before, or they could have found it in any dictionary. If "any variation from" an average is not "met by a corresponding variation in the opposite direction," so much the worse for that average.

Mr. Watson will, I hope, forgive the above remark, for I cannot believe that the report describes the subject of his paper, but I think that few readers would repress a smile at the Roy.Met.Soc,, on seeing such an account of its proceedings in the pages of our leading scientific journal.

I am, sir, yours obediently,

A F.R.Met.Soc.